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VOL. LXIV SEPTEMBER 3, 1926 No. 1653

CONTENTS

The British Association for the Advancement of Science:

The Scope of Organic Chemistry: PROFESSOR J. F. THORPE 211

Age, The Piper: PROFESSOR T. WINGATE TODD 216

Scientific Events:

The Laennec Anniversary; The Shedd Aquarium; Mathematics at Princeton University; The Golden Jubilee of the American Chemical Society 218

Scientific Notes and News 221

University and Educational Notes 224

Discussion:

The Calorimetric Method of determining Blood Flow in the Extremities: PROFESSOR G. N. STEWART. *The Shape of Cells in Masses:* COLONEL JOHN MILLIS. *The Big Stone Gap Shale of Southwestern Virginia:* DR. J. H. SCHWARTZ. *A Stock for the Mangosteen:* P. J. WESTER 224

Quotations:

The Oxford Meeting 227

Scientific Books:

Concerning Reptiles and Frogs, Bering's Voyages: DR. DAVID STARR JORDAN. *Sherborn's Animalium:* PROFESSOR BASHFORD DEAN 227

Special Articles:

Losses in Trout Fry after Distribution: DR. A. P. KNIGHT. *Sex Differences in Mortality and Metabolic Activity in Daphnia Magna:* DR. JOHN W. MACARTHUR and DR. W. H. T. BAILLIE 228

Science News x

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THE SCOPE OF ORGANIC CHEMISTRY[1]

THE chemistry of the compounds of carbon covers a wide field, wider than that covered by any other element. Its scope embraces all living matter, as well as the vast number of non-living substances which are produced through the agency of life. Moreover, it includes a very great number of compounds unrelated to life or to living processes which have been built up by the chemist in the laboratory by methods he has devised.

Already some two hundred thousand definite compounds have been tabulated in Richter's "Lexicon" and in the supplements thereto, and this number is increased yearly by several thousands through the agency of a band of zealous workers scattered over the globe. It may well be asked what is the good of continuing to increase this already astonishing number; and is the expenditure of time, labor and energy justified which lead to the discovery of some new fact having, apparently, no useful application to any department of human activity? The answers to these questions are quite clear and definite. You must acquire a knowledge of the simple before you can attack the complex with any hope of success. The element carbon has been used by nature as the basis of organized life because the capacity of carbon to combine with itself is shared by no other element, and it is upon this capacity that nature has relied in order to build up the tissues and reserve materials which form the living world around us. Moreover, since the compounds of carbon containing a moderate number of atoms of the element are usually crystalline or capable of becoming crystalline, and there are obvious disadvantages attaching to the use of potentially crystalline substances as the basis of living matter, it has been found necessary to employ the more complex carbon derivatives containing many hundreds of elemental atoms, which by reason of their high molecular complexities no longer possess, or seem capable of acquiring, a crystalline structure, but belong to the class of jelly-like or colloidal substances. Until we can determine how a small number of carbon atoms combine one with the other we can not hope to obtain any insight into the manner in which the more complex natural substances are built up, or any information regarding the way in which they are utilized to bring about the changes occurring during animal and vegetable metabolism.

[1] Address of the president of Section B—Chemistry—British Association for the Advancement of Science, Oxford, August, 1926.

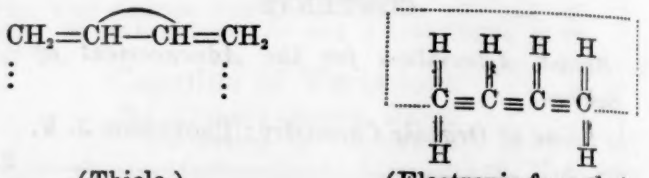
STRUCTURE

The science of structural organic chemistry is only just fifty years old. It was born when the genius of van't Hoff gave to the world the clue upon which the three dimensional formula we now use is based. It is, therefore, no inconsiderable achievement to have gained in so short a time a knowledge of many of the reactions and properties of the more simple complexes of carbon in combination with oxygen, nitrogen and other elements. But much yet remains to be done before we can attack with any real hope of success the problems which the chemistry of nature presents. It is true that the knowledge already gained has led to the synthetic preparation of quite a number of natural products, many of which are of service in relation to human needs. Many of the alkaloids, coloring matters like indigo and alizarine, camphor and a large number of natural products, have yielded the secrets of their structures and have been produced by laboratory methods and, where necessary, on the factory scale. But the synthesis of such compounds has not provided much insight into the mechanism leading to their production in nature, and indeed the reason for their occurrence in the plant is not understood. They are, moreover, crystalline substances which either occur in the plant as such or are formed by the hydrolytic fission of some more complex plant materials. Their homogeneity is, therefore, not open to doubt, and their degradation into known fragments and the rebuilding of these fragments into the original substances, although by no means easy, is nevertheless comparatively simple when the difficulties attending the investigation of more complex natural products are taken into account. Even so, some of the simpler type, for example, strychnine, still resist the attack of the chemist.

THE ELECTRONIC THEORY

It is clear that our knowledge of the finer mechanism of reactions is slight, and that great as has been the advance made through the discovery of van't Hoff, we are still at a loss to explain or predict the shades which determine whether one particular type of reaction will be more, or less, facile than another. The chief trouble seems to be that the electronic theories, which are quite satisfactory in themselves, are not yet developed so fully that they can include any quantitative statement relating to the changes in the free energy of systems. Yet it is evident that any theory of organic structure must conform to the modern physical conceptions of matter. The principle of shared electrons is primarily justified by its success in explaining the linking of atoms, *i.e.*, valency, and by its successful interpretation of the theory of co-ordination and "onium" salt formation. The subsidiary hypothesis of electron displacement also provides a means by which an explanation can be supplied to account for the ease of formation, stability and general reactions of conjugated systems, thus placing the hypothesis of Thiele on a sounder theoretical basis.

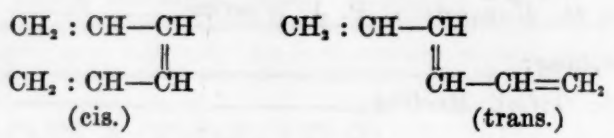
BUTADIENE



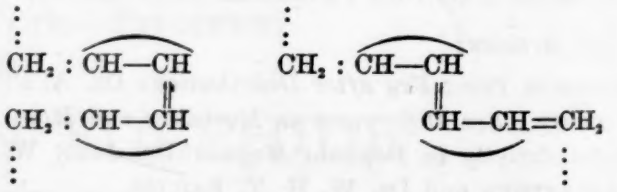
(Thiele.) (Electronic formula.)

In the formula for butadiene shown above the dotted line indicates the interchange of an electron between the two end carbon atoms of the system; it is to be assumed that this condition provides a point of attack and leads to the 1:4 addition which is characteristic of this substance. Evidence has been sought in order to substantiate this view, and with this object an extended investigation on the properties of hexatriene has been undertaken.

Hexatriene contains a three-conjugated system, and must, in accordance with stereo-chemical theory, exist in two forms, which may be represented diagrammatically thus:

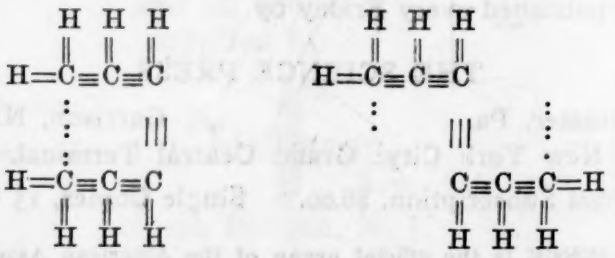


In accordance with the Thiele hypothesis these would be conjugated thus:



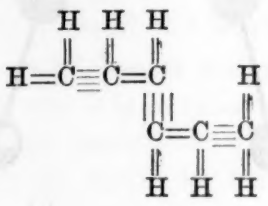
and there should thus be no difference in the behavior of the two forms towards additive reagents such as bromine.

On the other hand, if these two forms are expressed in terms of the electronic hypothesis thus:

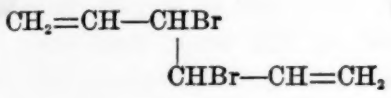


The cis form, in which the two terminal atoms are near together, might be expected to share the electron,

as shown by the dotted line, whilst the trans form, having the terminal carbon atoms too remote from one another to enable this interchange to take place, would react in the form



There can be no doubt that the hexatriene prepared by van Romburgh is the trans form. This, as its discoverer showed, adds on bromine in the positions 3:4 to give

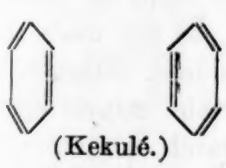


It is, therefore, not a conjugated system in the sense that butadiene is a conjugated system.

We have now succeeded in isolating cis-hexatriene, and are studying the action of bromine on it. If, as is to be anticipated, the addition takes place in the 1:6 positions, direct evidence will be available in favor of the electronic hypothesis. The work is, however, exceedingly difficult because, unlike those of the trans series, the cis compounds are liquids and therefore difficult to identify. Moreover, they are unstable and readily polymerize to resins on keeping. There is no doubt, however, that these difficulties will be overcome.

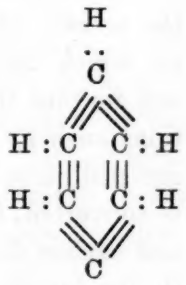
In the same way the Thomson[2] formula for benzene provides an expression for the intermediate state as postulated by Kekulé, and renders the so-called centric formula, which is meaningless, now unnecessary.

BENZENE



(Kekulé.)

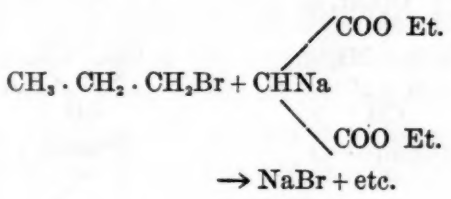
(Centric.)



(Thomson.)

There can be no question that the distribution of electrons among the carbon atoms and other atoms of organic molecules must determine the reactions of the complexes involved, and future research will no doubt lead to an advance in our knowledge concerning the causes which promote or retard this distribution.

The ductility of the carbon to carbon bonds which have now been clearly demonstrated enables us to impart strains to certain parts of an organic molecule at will, and it is reasonable to assume that such strain when once set up will be shared as far as possible equally by all the atoms of the system involved. If this distribution is, as Robinson postulates, effected by a restricted flow[3] of electrons from one atom to another in the molecule we have, at any rate, a definite picture of the process which the mind can grasp; and if the distribution leads ultimately—as is to be surmised—to the establishment of polar characteristics at different parts of the molecule, which will determine reactivity at those points, we are in a fair way to reconcile the views of various contending schools and to reach a general hypothesis acceptable to all chemists, and which may even satisfy the physicists. It seems that, despite the organic chemist's proneness and ability to distort the molecules with which he deals, nature has provided a means by which a certain degree of molecular equilibrium can be attained. Nevertheless, it will be by the investigation of the conditions leading to the setting up of strain and of the effect produced thereby that we shall gain the most information regarding the chemistry of carbon structures in the near future. The course of a reaction in organic chemistry which involves an equation such as the following



is determined by the tendency to form NaBr—the organic residues have to make the best they can of the situation, and the manner in which they will combine with themselves or react each with the solvent is dependent on the influence of many factors. Undoubtedly there will be a tendency to produce the most stable system and the one whose formation involves the greatest loss of free energy, but there must be a possible mechanism, and this involves the polar factors. Even these can not force a group into a position in which there is no room for it, and therefore the effect of polarity must always be dependent on steric conditions. No doubt polar conditions determine the order of priority of a number of possible arrangements, but it is the steric condition

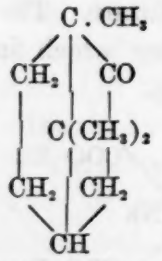
[2] See also H. Kauffmann ("Die Valenzlehre," 1911, p. 539).

[3] Robinson considers that an electron may leave its "moorings" on one of the atoms which holds it but never on both.

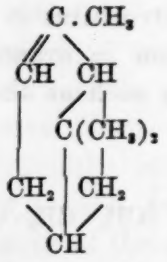
that determines which of these arrangements shall be followed.

STRAINLESS SYSTEMS

It is reasonable to assume that the organic substances that occur in nature as such are produced by means which involve the least expenditure of energy, and that they are, therefore, strainless. Among such natural products there are many containing carbon rings belonging to ring systems which can not normally be produced without distorting the carbon tetrahedral angles of the component carbon atoms, and thus imparting intramolecular strain to the compounds formed. Nevertheless, it is interesting to note the means adopted by nature to relieve this strain and thus to confer equilibrium and stability on quite unlikely ring systems. Ring systems stabilized in this way are found frequently among terpenes; two, namely, camphor and pinene, need only be mentioned to illustrate the general method. In camphor the bridged ring is stabilized by the presence of two dimethyl groups, and in pinene, where the junction of the inner ring has to take effect in the position 3, the presence of a double bond on the shoulder of the

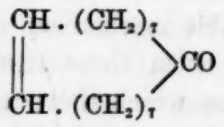


(Camphor.)

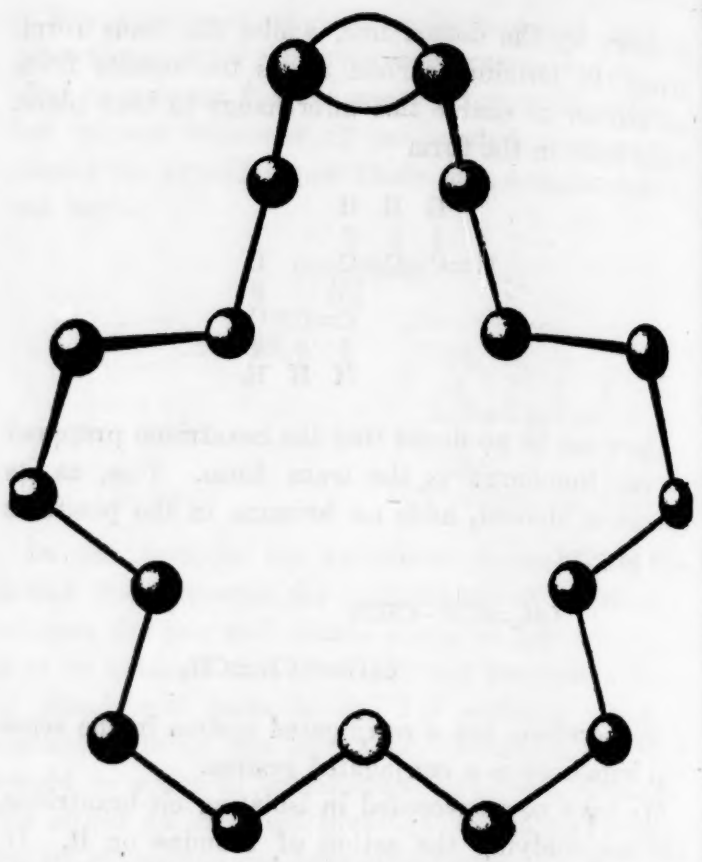


(Pinene.)

external ring is necessary. Still more remarkable examples are afforded by more complex natural ring systems. For instance, there is a substance named civetone, which is extracted from certain glands of the civet cat. There is no doubt as to its structure, which has been shown to contain a 17-membered ring, thus:



The evidence of structure being derived both from a study of the degradation products of the substance as well as by its recent synthesis. If this compound is set up on the tetrahedral models, thus



it will be found to form a triplanar figure which is strainless; the condition being produced by the presence of the double bond in the position shown.

BIOCHEMISTRY

In its earliest days the science of organic chemistry dealt only with those compounds which were derived from natural sources, and it was regarded as certain that such substances could only be produced through the agency of life and by no other means Since then this theory has been shown to be wrong by the preparation in the laboratory of many substances identical with those formed during the operation of life processes. Nevertheless, the more complex substances which nature utilizes in building up her animal and vegetable structures still show no signs of yielding the secrets of their constitutions, or the mechanism by which they are produced. Indeed, although we can imitate in the laboratory certain natural operations such as the hydrolysis of starch to glucose, we are still quite ignorant of the means by which glucose is converted, by the appropriate enzyme, into alcohol and carbon dioxide, neither can we imitate this process in the laboratory.

When once the chemist has passed beyond the crystalline and the distillable he enters a region full of difficulties, because he has few means either of purifying the materials with which he has to deal, or of determining their homogeneity when they have been purified. These are the real difficulties which confront the biochemist when he approaches his sub-

ject from the structural side of organic chemistry. Biochemistry is in the unique position of being both a descriptive or observational science as well as one of the experimental sciences. From the biological side it has at its disposal the wealth of knowledge acquired by the physiologists and pathologists, and from the chemical side it is in touch with the recorded experience of several generations of organic chemists. If biochemistry is to justify its name it must carry out its function of bringing into line the discoveries of the physiologists with organic chemical structure, for by this means only will it be possible to gain an insight into the chemistry of natural processes which it is the object of biochemistry to discover. It is far from my object to disparage the wonderful work which has been done and is being done by physiologists and pathologists in their attack on the mechanism of normal and abnormal life processes. Their record speaks for itself. But too little is being done to approach the problems from the purely organic chemical side, and too few of the people engaged in biochemical research have an adequate knowledge of organic chemistry or the methods of the organic chemist. The number of organic chemists who are cooperating with biologists in their attack on natural processes is too few. Indeed, the very difficult question arises here as to how best to organize methods for dealing with problems which are essential borderland problems between two great sciences. I do not propose on this occasion to discuss the vexed question of the chemical engineer, but actually the analogy between this hybrid and the biochemist is fairly close. Is the biochemist to be a biologist with a knowledge of chemistry, or is he to be a chemist with a knowledge of biology? I refer, of course, to the method of training required for a man or woman who proposes to take up biochemical research during the fourth year. Given twenty years and the requisite capacity it is, of course, possible for a man to acquire sufficient acquaintance with both sciences to render him an effective worker in the borderland field, altogether here again the temperament which promotes enthusiasm for research in the experimental sciences and that which leads to initiative in the descriptive sciences is not usually found in the same individual. As knowledge increases the need for specialization must also increase, because the time factor, that is the time during which it is possible for a student to undergo training, can not be prolonged beyond a certain period. Even at the present time it is an open question whether it is possible to give a student a special training in more than one science and in the sciences subsidiary thereto in the time available, and this problem will become more acute as knowledge increases. It has been suggested that we should revert to the older method by which a student was instructed in, say, three sciences without any special training in any one of them, and doubtless this method was a good one for the requirements of those times. But the day of the universalist is past, and general scientific culture has become a luxury of the leisured classes. It is only by the aid of the specialist that, nowadays, we can hope to obtain advances in knowledge either in the sciences or in the sciences applied to industry.

It seems that the best method to attack problems in the borderland subjects is by cooperation between two types of trained investigators. In the case of biochemistry, for example, by the provision of trained students of two kinds, the one trained in physiology but with a sufficient knowledge of organic chemistry to promote sympathy with and knowledge of the chemist's point of view, and the other trained as an organic chemist with a similar knowledge of the methods and requirements of the physiologist. The former would be a trained physiologist who would devote his final year to organic chemistry, the latter an organic chemist who would devote his final year to a study of physiology. This is, of course, no new idea, but is one which is being carried out in at least one institution in this country in connection with other borderland subjects. But it is the absence of any real attempt to approach biochemical problems from the chemical side that renders it particularly desirable that the need for some such scheme should be emphasized. It is true that the fault is largely on the side of the organic chemists who, for the most part, seem appalled by the difficulties attaching to the study of natural processes. The difficulties are indeed great, but not insurmountable. We are far from gaining any insight into the meaning of life, but it is not unlikely that we shall, in the near future, obtain some information regarding the mechanism of the action of the enzyme, the important agent in the non-living transformation of living matter into chemical products. It may be that organic chemists are waiting to see how Willstätter, who has already made great progress in enzyme chemistry, will surmount the difficulties confronting him, and it may well be that this great organic chemist will introduce new methods of attack which will open up fresh fields for investigation.

ANALYTICAL

Except for the substitution of gas for charcoal, it can not be said that the ordinary methods of analysis employed by the organic chemists have changed much since the days of Liebig. They have been modified, notably by Dennstedt, and more recently some have adopted the microchemical methods

introduced by Pregl, but the older methods, for example, the long and tedious process for the estimation of halogens by the method of Carius, are still in vogue in many of our laboratories and are taught to the students. In any case the usual operation entailed by the estimation of carbon and hydrogen, nitrogen, sulphur and the halogen requires considerable time, which has not been materially shortened by the introduction of the less cumbersome methods due to Dennstedt. Pregl's methods, in which a very small quantity of material is used requiring the provision of a special type of balance, have been tried in many laboratories, and have found favor, it is understood, in several of them, more particularly abroad. But the general experience has been that the technical skill required to obtain good results is acquired only after long practice, and that whereas the methods are useful for gaining an indication of structure when the quantities of material at hand are so small as to necessitate their use, yet when a sufficient quantity of substance is available the older methods are more reliable and more easily carried out. It is interesting to note that the new methods which have been introduced by Professor ter Meulen, of Delft, are going to be described to us by Professor ter Meulen himself, who is fortunately with us at this meeting. Professor ter Meulen will give an account of his methods on Tuesday morning, and they will be shown in actual operation during the soirée on Tuesday evening. Chemists will then see that a great saving of time can be effected by methods which can not only be used to analyze the small quantities employed by Pregl, but also quantities of 0.1 gm., such as organic chemists have been accustomed to use in the past, and which have been shown to produce the most accurate results.

THE UTILIZATION OF FOREST PRODUCTS

The immense number of organic compounds distributed among the plants, trees and grasses which form the forests and jungles of the world, offer a wide field for research which has still much to yield. Our knowledge of the medicinal properties of organic substances and the various uses to which they could be put in the service of mankind did not come to us through any effort of the chemist, but as the outcome of a process of trial and error which is as old as the human race itself. These products were obtained from vegetable materials present in the forests, and as time went on they were extracted in a form possessing some degree of purity, and the plants containing those with specially valuable properties were cultivated for their production. As soon as a theory of organic structure was evolved upon which prediction could be based, these useful products were subjected to close investigation, and in several cases they were prepared by laboratory means. As an outcome several of them, such as indigo and alizarine, were found to be capable of production more economically by the chemical method than by the processes of life, and the natural substances were rapidly replaced by the artificial products. Others still resist all efforts to unravel their structures and remain still unsynthesized. Nevertheless it has been by a study of the chemical structure of natural products that much has been learned regarding the relation between chemical composition and physiological action, and although it may not have been found possible economically to prepare the natural substance itself, the clue revealed by the determination of structure has led to the production of other substances which have not only shown the properties of the natural compound in an enhanced form, but have also exhibited other valuable physiological effects. The determination of structure has, therefore, two objects—to prepare the natural substance and to ascertain the particular arrangement of the atoms in the molecule which confers on it the properties which determine its value. The determination of the structure of indigo led not only to the production of the blue natural indigo, but enabled indigoes of every shade of the spectrum to be prepared as commercial products. The determination of the structure of cocaine revealed the molecular complex which conferred on this substance its power to act as a local anesthetic, and has led to the production of a number of other substances possessing this valuable property, but without the special disadvantages attaching to the use of the natural substance. Examples of this kind are numerous and should be increased. A systematic examination of our forest products would undoubtedly lead to the discovery of many others and would provide opportunity for the investigation of many other important problems, such as, for example, the utilization of forest grasses as a source of power alcohol.

Systematic team-work research by organic chemists in close association with botanists is required, and now that the Forest Production Research Board of the Department of Scientific and Industrial Research is in active operation, no doubt this branch of its work will receive attention.

(To be concluded) J. F. THORPE

AGE: THE PIPER[1]

I HAVE chosen as my title "Age: the Piper," for I propose to show how we, the younger partners in this dance of life, must foot the measure piped by our

[1] Address delivered at the Alumni Banquet of the Medical School, Western Reserve University, June 15, 1926.

seniors. Take it as you will, the inspiration and the judgment alike lie at the charge of our elders. They have set the pace and to them we must answer: it is a serious business.

Sir James Barrie, speaking the other day at a banquet for the Australian cricketers in England, spoke whimsically of one of those who, having set out upon the long journey of the dead, paused to lean his elbows on the village gate and watch the cricket match on the green. "What a terrible thing if he had to rejoin his fellows feeling that we, his successors, were not playing the game." Try as we will, we may not, as Dr. Stewart assured us at the alumni banquet a few years ago, evade the responsibility we owe to those who have passed along this way ahead of us.

How early in our consciousness this responsibility becomes fixed I, an exponent of the science of the sepulcher, must leave to the psychologists. Almost a thousand years ago Saint Hildegarde of Bingen wrote her vision. "And I saw the likeness of a woman having a complete human form within her womb. And then, by a secret disposition of the Most High Craftsman, a fiery sphere, having none of the lineaments of a human body, possessed the heart of the form, and reached the brain, and transfused itself through all the members. And I saw that many circling eddies possessed the sphere and brought it earthward, but ever with renewed force, it returned upward and with wailing asked 'I, wanderer that I am, where am I?' 'In Death's shadow.' 'And where go I?' 'In the way of sinners.' 'And what is my hope?' 'That of all wanderers.'" But when we have come to this earth, when in the process of years we have learned patience and persistence, when we have at last found that the mists about the goal are shifting and transient, what has age to contribute to our philosophy?

Seventy-five years have passed since Wordsworth died and the Prelude was published: one hundred and twenty since it was in its first form, finished but only at this date so long afterwards are we able to study the textual changes made during those forty-five years.

> The mind of man is framed even like the Breath
> Of harmony in music.

was the original script.

> Dust as we are, the immortal spirit grows
> Like harmony in music.

is the text as Wordsworth the elder finally left it.

How long has this subtle influence been at work in mankind? How long has it been possible to leaven thus our common heritage?

All of you have seen the wonderful palace of medical research and training put at our disposal by the inspiring generosity of Mr. Samuel Mather, and many of you, passing by the tremendous collection of human material in the museum named in honor of our beloved dean, must have wondered why this feverish haste to gather such quantities of the evidence of our mortality. Some of you know that now, in consequence, for the first time it is possible to study quantitatively the life history of mankind, not merely of the population lately stirring restlessly along the southern shore of these great lakes, but also, through this sample, the life history of all mankind. Secrets hitherto hidden from our knowledge are breaking upon us with startling vividness and we may now more accurately adjudge our inheritance. It seems a simple thing to state that owing to the opportunity provided in the vision of Dr. Hamann's life, it is now possible to discern with fair accuracy the precise age of any human skeleton. The bare fact smacks of the dry bones which gave it birth, but what possibilities it has opened up!

Away in that dusty corner of the earth called Pecos, in New Mexico, have lived a people undisturbed even by the violent travail of the New World in the sixteenth century. And there between 850 and 1800 A. D. there lived and died 560 persons who have bequeathed to us their records in their bones. Many died in childhood, others in early adolescence, most in the two decades between thirty-five and fifty-five years. During all these thousand years there has been no perceptible change in the actual duration of life at Pecos. But when we come to deal with the higher European civilization there is a different tale to tell.

Up in the English Lake District there is a shaggy moor overlooking the vast expanse of silted sand covered at high tide alone by a shallow sea: it is called the Birkrigg from the birches which dot its irregular rocky surface. There in the Bronze Age was a settlement—a lookout for the hinterland. Last summer I had the privilege of examining the sixteen burials in the adjacent disc barrow or Bronze Age cemetery. It came upon me with shock of surprise to find the sixteen bodies ranging in age from seventeen to thirty years. Yet the collateral evidence does not seem to indicate, as one might otherwise suppose, a military encampment of young people only. Why did these people die so young: that was the disquieting thought with which I left the district.

Hard upon the heels of this investigation I was called across the country to the town of Scarborough, situated on the edge of the naked cliff overlooking the North Sea like a sentinel watching Europe. Here time after time incursions of marauders landed from the wilder districts of Jutland and Scandinavia. In Bronze, Roman, Saxon and Norman times alike Scarborough was a fortified village. Under the chancel of the Norman church were recovered last year one

hundred and forty-six skeletons of folk who lived in the eleventh and twelfth centuries. Here as at Pecos the majority of the people died between thirty-five and fifty-five, the peak of mortality occurring at about forty years. Of the entire number only eight lived to see their sixtieth summer.

"To die of age," said Montaigne in the sixteenth century, "is a rare, singular and extraordinarie death, and so much lesse naturall than others. . . . It is an exemption, which through some particular favour Nature bestoweth on some one man, in the space of two or three ages." On attaining his thirty-ninth birthday the same philosopher wrote in soliloquy, "Thou hast alreadie over past the ordinary tearmes of common life."

Twenty years ago Karl Pearson analyzed the curve of modern deaths obtained from English vital statistics. He found that the peak of death occurs at seventy-two years but that there are lesser peaks in childhood, in adolescence and in middle age at forty-two. All these peaks except that of old age I have found in various ancient populations of which I have mentioned merely three. Again the peak of old age death does not occur among the unfortunates who, having failed to cope successfully with the conditions of life to-day, find their last resting place in what has become the permanent morgue of our city of Cleveland, namely, the anatomical laboratory.

It is this last peak of our mortality, occurring only in quite modern days and presenting itself at seventy-two, full thirty years after the peak of middle age death, which is the most suggestive and intriguing fact emerging from our study. There have been old men in all periods of the history of mankind, but they have been rare and marked men. "And the Lord commanded Moses, concerning the Levites, saying. . . . And from the age of fifty they shall cease waiting upon the service, and shall serve no more."

Precisely when this tremendous increase in the average actual duration of life first appeared as a result of greater safety and improved social conditions, we do not yet know: it can hardly have been much more than two centuries ago. But consider the effect. When the normal age of death was the early forties a man's experience died with him and had little or no opportunity of leavening the population at large. During the last two centuries, through the warding off of the Reaper for thirty years more, the younger members of civilized communities have enjoyed all the benefits of the experience of their elders. We seek for the cause of the enormous strides in discovery and invention during the past century. May not the chief contributing factor be precisely that our fathers and uncles abide to guide us out of the stores of their accumulated wisdom? May not the rapidly increasing sensitiveness of the civilized conscience with its resultant effect upon slavery, child labor, the rights of womanhood, be due in the main to the influence of our mothers who bloom as evening primroses in the twilight of life?

There is evidence indeed that the pace we have attained is too great for us. During the past twenty-five years we have been dying, on the whole, earlier than statistics of the expectation of life would lead us to anticipate: that is an issue for the future with its frantic haste. At the moment and for the last thought I would leave with you this evening may we not concentrate upon this theme that the major factor concerned in the betterment of living conditions to-day is the abiding with us of our elders, men and women alike? My closing emphasis rests upon the influence among us of the wisdom of our fathers and the grace of our mothers.

In Wordsworth's Prelude there is a phrase picturing that wonderful countryside of English lake and mountain. This phrase, so apposite for the beauty of age, is my final figure in the contemplation of these, our elders, "Clothed in the sunshine of the withering fern."

T. WINGATE TODD
WESTERN RESERVE UNIVERSITY

SCIENTIFIC EVENTS

THE LAENNEC ANNIVERSARY[1]

ONE hundred years ago there died in the village of Quimper, Brittany, one whose contribution to medicine in general, and to our knowledge of tuberculosis in particular, was of great magnitude. René Theophile Hyacinthe Laennec was his name. He invented the stethoscope, wrote a masterful treatise on its use, "Traité de L'auscultation Mediate," organized and augmented the then current knowledge on the pathology and the symptomatology of tuberculosis and coined a descriptive terminology which is still in use for the designation of sounds elicited upon auscultation.

Withal he was a clinician of the first rank. "Perhaps the greatest that ever lived" (Krause). His studies were not confined to the lungs and to tuberculosis. The cardiac sounds, normal and pathologic, were included in the domain of his researches. He described the first and second cardiac sounds and the various types of pathologic murmurs. He understood their significance, as well as the pathology and symptomatology of pericarditis.

Laennec studied medicine in Paris under Corvisart, physician to Napoleon Bonaparte. Laennec was a

[1] From the *Weekly Bulletin* of the City of New York Department of Health.

brilliant and industrious student and quickly attracted the attention of his masters. His early studies were in pathologic anatomy. To this branch he contributed the term cirrhosis of the liver, and described the condition to this day designated as Laennec's cirrhosis.

In 1816 Laennec was appointed chief physician to Neckar Hospital. In this year Laennec made his great discovery, the stethoscope. "I happened to recollect a simple and well known fact in acoustics." That was the mainspring for the discovery of an instrument ever since the constant and most common tool of the physician. The "fact in acoustics" was simple and well known, but no one before had thought of its application to the collection and transmission of the sounds in the human machine—no one, if we except that rare and inspired genius Robert Hooke, who intellectually anticipated so many epoch-making discoveries in the numerous branches of science.

In the simplicity of the underlying principle, the discovery of the stethoscope parallels the invention of percussion, credited to Avenbrugger, the son of a wine merchant. He too remembered "a simple and well known fact in acoustics," that when one taps a wine barrel below the fluid level it sounds dull, if tapped above, it sounds hollow.

It was Corvisart, the teacher of Laennec, who by his translation of Avenbrugger's "Invention Novum ex Percussione Morbos Detegendi" brought percussion to the notice of the medical world, and it was Laennec, Corvisart's pupil, who invented the second instrument for thoracic examination, without which, as Otis said, "we could hardly have arrived at any degree of precision or certainty in thoracic pathology."

THE SHEDD AQUARIUM

APPROXIMATELY 131 permanent exhibition tanks, which will contain a greater variety of fish than is shown in any aquarium now in existence, will be built into the Shedd Aquarium in Grant Park, which is being constructed at a cost of three million dollars, according to an announcement made by George Morse, director, and Walter H. Chute, associate director.

These tanks will range in capacity from 375 to 13,500 gallons of water, with a total capacity of about 350,000 gallons. In addition there will be about 80 tanks in which a reserve supply of fish for replacement purposes will be kept. Approximately 900 lineal feet of glass will be used for the tanks. Two reservoirs will be built with a total capacity of 2,000,000 gallons of water, half fresh and half salt.

The New York City Aquarium, now the largest in the world, has 89 tanks with 455 lineal feet of glass and 29 reserve tanks; Philadelphia, 114 tanks, 511 lineal feet of glass and 36 reserve tanks; London, 90 tanks, 500 lineal feet of glass, and Brighton, England, 50 tanks, 750 lineal feet of glass and no reserve tanks.

The permanent exhibition tanks will be about equally divided between fresh and salt water. In addition there will be a small hatchery for exhibition purposes only and a larger hatchery for actual hatching as well as a balanced aquarium room of about 50 feet in diameter. In this room will be exhibited representatives of the small fish of the world.

Five separate systems of water are planned. One will be a natural fresh water system with 43 tanks in which will be exhibited native fishes of Illinois and surrounding states and such other fishes as are found in water of this nature.

An artificially refrigerated water system of 12 tanks will be used for showing trout, salmon and other cold-water fish. A heated fresh water system of 11 tanks will be used for tropical fresh water fish.

Two systems of salt water will be installed, one refrigerated and the other heated, the former to have 22 tanks and the latter 43 tanks. In the heated system will be shown multi-colored fishes from Florida, Hawaii and other tropical waters. The refrigerated system will be divided among native fishes of the Atlantic and Pacific coasts of the United States.

Two of the largest practical tanks are in the specifications. Each tank will be 30 feet long, 10 feet from front to rear and six feet in depth. Larger tanks are not practical because of the limitation of vision. In these tanks will be kept representatives of the giant fishes. One tank will be devoted to jewfish—a giant salt water member of the bass family—sharks and other large fish, while the other tank will hold sturgeons, catfish and muskallunge.

MATHEMATICS AT PRINCETON UNIVERSITY

EXTENSION of the department of mathematics of Princeton University, with the object of building up a tradition similar to that held by the Mathematical Institute of Göttingen, Germany, is recommended in a report just made public by the Princeton Fund. The report says Princeton has played a leading rôle in the advancement of mathematics in this country since the end of the nineteenth century and has the beginnings of what may become a brilliant mathematical tradition.

"For many years there have been frequent complaints that there is no school of applied mathematics in the United States," according to the report. No serious attempt, however, has been made to establish such a school in the proper manner, that is, by developing tendencies which have set spontaneously in this direction. There is now opportunity at Princeton to make such a development.

The statement alludes to the mathematical tradition of the Göttingen Institute, which is said to have been built up by a group of men of all ages, who have been working together so that necessary replacements have been made gradually without interrupting the continuity of the personnel.

The Princeton Fund states that a similar history could be realized at Princeton "if the opportunity which has come to the university is assured prompt and full realization."

The Princeton Fund cites as means to this realization the following: Endowment for research professorships; increase of personnel with schedules compatible with better teaching and more research; a department research fund to meet changing conditions; a visiting professorship; a group of offices and other rooms for mathematical work, both undergraduate and advanced; continued financial support for the "Annals of Mathematics" which has been published for the last fifteen years by the Princeton department of mathematics, and a number of graduate scholarships.

THE GOLDEN JUBILEE OF THE AMERICAN CHEMICAL SOCIETY

THERE have been printed in SCIENCE several notes in regard to the meeting of the American Chemical Society to be held in Philadelphia next week. The general program as now arranged is as follows:

Monday, September 6

9:00 A. M.—Registration Bureau opens in Ball Room Lobby, Bellevue-Stratford Hotel.

9:30 A. M.—Council Meeting—Bellevue-Stratford Ball Room.

2:00 P. M.—General Meeting—Bellevue-Stratford Ball Room.

Address of Welcome:

W. T. TAGGART, chairman of the General Local Committee.

HON. W. FREELAND KENDRICK, mayor of Philadelphia.

JOHN FRAZER, dean of Town Scientific School, University of Pennsylvania.

Response:

JAMES F. NORRIS, president, American Chemical Society.

Addresses:

PRINCE P. GINORI CONTI, "The Development of Chemical Industry in Italy."

IRENE DU PONT, "The Dyestuff Industry, Forerunner of What?"

PAUL SABATIER, "La Chimie Modern et Marcelin Berthelot."

8:30 P. M.—Entertainment, Reception and Dance—Elks' Club, Broad Street above Vine.

Tuesday, September 7

9:30 A. M.—Divisional and Sectional Meetings at University of Pennsylvania (see Divisional Programs).

12:30 P. M.—Luncheon—University of Pennsylvania.

2:00 P. M.—Divisional and Sectional Meetings continued.

8:00 P. M.—General Meeting—Bellevue-Stratford Ball Room.

President's Address, JAMES F. NORRIS, president, American Chemical Society—"A Look Ahead."

Award of the Priestley Medal to DR. EDGAR F. SMITH.

Priestley Lecture, DR. EDGAR F. SMITH—"Joseph Priestley."

Wednesday, September 8

9:30 A. M.—Divisional and Sectional Meetings—University of Pennsylvania.

12:30 P. M.—Luncheon—University of Pennsylvania.

2:00 P. M.—Public Meeting at the Academy of Music, Broad and Locust Streets.

Addresses:

IRVING LANGMUIR, "Flames of Atomic Hydrogen."

HUGH S. TAYLOR, "Chemical Reaction of Atomic Hydrogen."

ERNST COHEN, "Caricature in Science."

Presentation of Diplomas of Honorary Membership.

Presentation of Special Award to PAUL SABATIER.

8:00 P. M.—Banquet—Bellevue-Stratford Ball Room—In honor of our Founder Members.

Thursday, September 9

9:30 A. M.—Divisional and Sectional Meetings—University of Pennsylvania.

12:30 P. M.—Luncheon—University of Pennsylvania.

2:00 P. M.—Divisional and Sectional Meetings continued.

4:00 P. M.—Award of Honorary Degrees by the University of Pennsylvania, University Museum Auditorium, 34th and Spruce Streets.

6:00 P. M.—Group Dinners.

8:30 P. M.—Performance of the Pageant "Freedom" at the Sesqui-Centennial Stadium (by invitation of the Sesqui-Centennial authorities).

Friday, September 10

9:30 A. M.—Divisional and Sectional Meetings—University of Pennsylvania.

12:00 M.—Luncheon—University of Pennsylvania.

2:00 P. M.—Divisional and Sectional Meetings continued.

2:00 P. M.—Special boat leaves wharf at the foot of Chestnut Street for excursion on Delaware River.

8:00 P. M.—Boat returns to Chestnut Street Wharf.

On the Sunday preceding the meeting there is an excursion to Northumberland, the home of Priestley, details regarding which have been printed in SCIENCE.

SCIENTIFIC NOTES AND NEWS

DR. JOHN GEORGE ADAMI, from 1892 to 1919 professor of pathology in McGill University and since then chancellor of the University of Liverpool, died on August 29, aged sixty-four years.

DR. ARTHUR J. COMPTON, professor of physics in the University of Chicago, has been elected a member of the R. Accademia Nazionale dei Lincei at Rome.

THE degree of doctor of science will be conferred by the University of Pennsylvania on M. Paul Sabatier, who is head of the delegation of French chemists who arrived in New York on August 27 to attend the fiftieth anniversary meeting of the American Chemical Society.

THE White medal of honor of the Massachusetts Horticultural Society has been awarded by the committee, of which Professor Charles S. Sargent, of the Arnold Arboretum of Harvard University, is president, to Pierre S. du Pont, who maintains open to the public a glassed-in winter garden of six acres.

THE Edison medal for 1925 will be presented to Dr. Harris J. Ryan, past-president of the Institute of Electrical Engineers and professor of electrical engineering at Stanford University, at the annual dinner of the Pacific Coast convention, which opens at Salt Lake City on September 1.

THE Cameron prize in practical therapeutics of the University of Edinburgh has been awarded to Dr. H. H. Dale, head of the department of biochemistry and pharmacology under the National Research Council.

HORACE T. HERRICK, acting chemist, has been appointed chemist in charge of the color laboratory, Bureau of Chemistry of the U. S. Department of Agriculture.

W. J. CLENCH, of the Kent Scientific Museum, Grand Rapids, Mich., has accepted the position of curator of mollusks at the Museum of Comparative Zoology, Harvard University.

DR. LAURENCE H. SNYDER, associate professor of genetics at North Carolina State College, has resigned to accept appointment as biologist at the Maine Experiment Station.

FREDERICK S. BACON, formerly president of the Puritan Dye and Chemical Company, has joined the organization of Arthur D. Little, Inc., chemists, engineers and managers, of Cambridge, Mass.

DR. GEORGE DENTON BEAL, associate professor of chemistry in the University of Illinois, has been appointed to an assistant directorship in the Mellon Institute of Industrial Research at the University of Pittsburgh. Dr. Beal will be in supervisory charge of industrial fellows, who are conducting researches in the field of pharmaceutical chemistry.

DR. TH. MORTENSEN, of the University of Copenhagen, known for his work on Echinoderms, is spending the summer in America. During July he was at the Bermuda Biological Station; August was spent in Cambridge at the Museum of Comparative Zoology, and September will be devoted to the National Museum at Washington. On returning to Europe, Dr. Mortensen will visit museums in Paris, Amsterdam, Munich, Berlin and Hamburg.

C. F. SHAW, professor of soil technology in the University of California, has returned from Mexico City, where he had been advising the Comision Nacional de Irrigacion regarding the organization of an agronomic and economic department. The Mexican government is planning an extensive development of irrigation in various parts of the republic, and the new department is being organized to study the quality of soil and economic feasibility of the proposed irrigation projects. While in Mexico Professor Shaw examined and reported on the Santiago project in the State of Aguascalientes and also reviewed the Guatimape project in Durango and the Popigochic project in Chihuahua.

DR. E. W. NELSON, chief of the Bureau of Biological Survey, has returned to Washington from Winona, Minn., where he held conferences with the governor and the state game warden of Iowa and others in connection with the administration of the Upper Mississippi River wild life and fish refuge. He also made an inspection trip of the refuge from Davenport, Iowa, to Wabasha, Minn., a distance of about 300 miles, in a Bureau of Fisheries' boat, in company with H. L. Canfield, representing the Bureau of Fisheries, which is cooperating with the Biological Survey in the administration of this refuge.

DR. WALDO L. SCHMITT, curator of marine invertebrates of the U. S. National Museum, sailed for South America on August 7. He plans to make a study of the fauna, with special reference to crustacea.

THE Connecticut Agricultural Experiment Station at New Haven has recently been presented with two portraits, one of its founder, Professor Samuel W. Johnson, the gift of Mrs. Thomas B. Osborne. The other is a portrait of Dr. E. H. Jenkins, director emeritus, painted by Ellen Emmett Rand.

THE Kitasato Institute, Tokyo, held an annual commemoration service on May 27 for Dr. Robert Koch, under whom Dr. Kitasato pursued his studies when in Germany.

THE Academy of Science, Letters and Arts of

Besançon has taken the initiative in the erection of a statue to the Compte de Chardonnet, who at Besançon first founded a factory for the manufacture of artificial silk in 1890. There are said now to be throughout the world 300,000 workmen engaged in this industry.

WE learn from *Nature* that the centenary year of Lord Lister's birth will be celebrated in Edinburgh in July, 1927, during the meeting of the British Medical Association. The committee responsible for the celebration is anxious to interest students and young graduates in the significance of Lister's work, and is offering a prize of a gold medal and £25 for the best essay upon "The Influence of Lister on the Evolution of Surgery." The prize is open to registered students and graduates of not more than one year's standing of any medical school of the British Empire.

AT the Oxford meeting of the British Association, representatives from South Africa repeated their invitation to the association to meet there in 1929 and gave assurance of government and scientific support. It was agreed to instruct the council to make the necessary inquiries as to the date, period of absence from England, expense to visiting members and financial support. Cordial thanks were given to South Africa, and the committee was almost unanimous in favor of acceptance.

AT the final business meeting of the British Association for the Advancement of Science, it was reported by the treasurer that the financial success of the Oxford meeting, which nearly equalled that of the Manchester meeting of 1887, had made it possible to provide for a deficit caused by the grants in aid of research at the Southampton meeting, and to give an increased sum this year. Grants amounting to £984 were made.

A CONFERENCE at which it is expected that a number of European leaders in scientific and industrial research will be present will be held in Pittsburgh from November 15 to 19. The purpose of the conference is to discuss the possibility of the greater and more economical use of bituminous coal.

THE fifth annual meeting of the National Conference on Pharmaceutical Research will be held at Hotel Bellevue-Stratford, Philadelphia, Pa., on Saturday, September 11. The tentative program includes: Reports of officers; reports of the 10 standing committees; report of special committee on committees; report of special committee on book of research achievements; reports from delegates from the affiliated organizations; general discussion on (a) census of research, (b) graduate students in pharmacy and their research work, (c) research topics, (d) research grants and prizes, (e) research fellowships and scholarships; new business; election.

THE German society for the study of diseases of digestion and metabolism will hold a congress in Berlin under the presidency of Professor von Bergmann, of Frankfort, from October 13 to 16.

THE third International Congress of Individual Psychology will be held at Düsseldorf from September 26 to 29.

THE Rockefeller Institute has presented the Norwegian government with a million gold crowns for a state serum and vaccine institute.

THE president of Panama has invited a party of professors from the Johns Hopkins, Harvard, Minnesota universities and the U. S. Deartment of Agriculture to come to Panama, to establish a central research laboratory at Penonomé to study conditions of the soil favoring the development of hookworm and its epidemiology and treatment. The International Health Board of the Rockefeller Foundation is financing the study.

IN accordance with the wish of the late Charles Lawrence Hutchinson, of Chicago, Mrs. Frances Kinsley Hutchinson has given to the University of Wisconsin the estate of Wychwood, on Lake Geneva, as a sanctuary for plants, birds and small animal life. The estate occupies seventy-two acres and is endowed under a trust fund. The trust agreement provides for a self-perpetuating board of three trustees, one an authority on plant life, one eminent in bird knowledge and the third a business man. The first board will consist of Dr. Henry Cowles, of the department of botany at the University of Illinois; Dr. Robert Ridgway, ornithologist, and Noble Brandon Judah, nephew of Mrs. Hutchinson. The trust agreement provides that the plants and blooms shall be protected from "the menace of the flower-picking public." Visitors will be admitted by permits only.

THE valuable collection of Vancouver Island Indian curios from the Patricia Bay Reservation has been sold to the American Museum of Natural History by Mrs. John Newbigging, of New York, owner of the property. The collection included handsomely carved stone idols, axe handles, large numbers of harpoons, bone needles and arrow heads.

THE *Journal* of the American Medical Association states that the trustees of the University of Pennsylvania and the Diagnostic Hospital of Philadelphia have filed a petition in common pleas court for permission to merge the hospital with the graduate school of medicine of the university. The agreement sets forth, it is reported, that Dr. Henry B. Ingle, of the

Diagnostic Hospital staff, shall be the first director of the diagnostic clinic of the graduate school of medicine, and that the university shall establish the clinic within a year from the date of occupancy of the hospital building soon to be erected at Nineteenth and Lombard Streets. The agreement provides, also, that the dean of the graduate school of medicine, George H. Meeker, Ph.D., and Dr. Ingle, the director of the clinic, shall endeavor to arrange so that other members of the staff of the Diagnostic Hospital may assist in the work of the graduate school. It is further agreed that all assets of the hospital shall be transferred in fee simple to the university to be held as a separate trust fund to be known as "The Endowment Fund of the Diagnostic Hospital," to be invested and the income to be used for the general purposes of hospitals.

WE learn from *Nature* that Herr Rasmussen, the Danish Minister of Defence, who is shortly paying an official visit to Denmark's colony, the Faroe Islands and her sister state, the republican kingdom of Iceland, intends thereafter to proceed to the lonely, uninhabited island of Jan Mayen, lying between Greenland, Iceland and Norway. The announced object of the minister's visit is to arrange for the erection there of a Danish seismographic station. The Danish government owns the buildings on the island, which were given to them, it is said, by the Austrians, who once occupied Jan Mayen. It was made the station of the Austrian polar expedition of 1882–83, but has apparently remained unclaimed ever since, though Great Britain and Norway together established a "close season" for the seal fisheries. The whale and seal fisheries off the east and north coasts are very important during the summer. Jan Mayen Land, which was discovered in 1611, by the Dutch navigator of that name, is of volcanic origin, is some 35 miles long, and practically covered with immense glaciers and, in winter, frozen waterfalls. Its highest point, an extinct volcano, is 8,350 feet high.

A GOLD ore deposit thought to be of large proportions has been discovered at Boliden, in the province of Vesterbotten not far from the Arctic Circle, according to Dr. Axel Gavelin, head of the Swedish Geological Survey. Electrical prospecting methods developed by Hans Lundberg and Karl Sundberg, mining engineers, are responsible for the find. It comprises thirty-four ore bodies, all covered by glacial drift, swamps or lakes. Besides gold, the ore contains silver, copper, sulphur, arsenic and iron. The arsenic deposit is thought to be the richest in the world. Assay indicates that each mined meter will yield 850 pounds of gold, 2.5 tons of silver, about 1,300 tons of copper, and more than 2,000 tons of arsenic. Preparations for the construction of a railroad to Skelleftea on the Baltic coast have begun.

THE Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for 1925 has been published. The publication shows the results of the survey's work in England, Wales and Scotland. In nearly all the important coal fields surveyors are revising the old geological maps, and the summary contains much new information relating to the general geology and the special details of the worked seams in these coal areas. The report of the Geological Survey Board states that substantial progress has also been made in dealing with the accumulated arrears of publication of water-supply memoirs. The memoir on Wiltshire was published at the end of 1925, and that on Dorsetshire was in the press. Memoirs on the water supply of Worcestershire, Warwickshire and Somerset had been prepared and awaited publication. With a view to keeping the published information up to date, steps are being taken to prepare for publication the latest records of the London District and of Sussex, of which there are many in manuscript in the Survey Office.

THE Geneva correspondent of the London *Times* reports that observations of Professor P. L. Mercanton, of Lausanne, of the retreating movement of the Swiss Alpine glaciers which began in 1922 show that these were continued throughout 1925. He writes: One example may help to show the size of this movement. The mass of new snow reached a depth of 7 feet on the Orny glacier at the beginning of the summer season; the quantity of snow that melted during the summer months reached a depth of 18 feet, so that the surface of the glacier sank by 11 feet. Out of 100 Swiss glaciers observed in 1925, 19 were advancing (23 in 1924), 11 were at a standstill (11 in 1924), and 69 were retreating (66 in 1924). The Saleinaz glacier advanced by 63 feet and the lower Grindelwald glacier by 29 feet; on the other hand, the Aletsch glacier retreated by 30 feet, the Allalin glacier by 30 feet, the Eiger glacier by 61 feet and the upper Grindelwald glacier by 50 feet. The consequence of this retreating movement is that the glaciers are now in a broken condition, cut by deep crevasses which make them difficult and sometimes dangerous to cross. There is every reason to believe that this is the beginning of a period of general retreat; if this be the case, it will be evidence in favor of the theory that the periodicity of the glacier movements is 35 years. During nearly 35 years ending 1922 there was a general advance of Alpine glaciers. It remains to be seen whether in another 33 years we shall be entering on another period of advance.

UNIVERSITY AND EDUCATIONAL NOTES

THE will of Dr. Charles W. Eliot, late president emeritus of Harvard University, leaves the bulk of his estate to his heirs and directs that the income from the Charles William Eliot Fund, raised for him by alumni, be given to the president and fellows of Harvard. The income from the fund, accrued and accruing, is to be applied at the discretion of the president and fellows of Harvard to the support of instruction or research in landscape architecture or preventive medicine. The amount is estimated at $200,000. The will further provides in connection with this bequest that in case any descendant of his by direct line should ever need aid in obtaining a thorough education, aid shall be provided from the income of the Eliot Fund.

DR. H. L. SHANTZ, botanist, senior pathologist in charge of plant geography and physiology in the Bureau of Plant Industry, U. S. Department of Agriculture, has been appointed professor of botany at the University of Illinois.

DR. RALPH V. CHAMBERLIN has resigned his position as curator of arachnids, myriopods and worms at the Museum of Comparative Zoology of Harvard University to become head of the department of zoology at the University of Utah.

DR. H. A. SIMMONS, of the University of Pittsburgh, has been appointed to an assistant professorship of mathematics at Northwestern University.

DR. RAY H. DOTTERER, of the Pennsylvania State College, has been appointed professor of psychology at Franklin and Marshall College.

PROFESSOR B. BROUWER, director of the neurological institute and laboratory of the University of Amsterdam, has been called to the Johns Hopkins University.

A. E. INGHAM, fellow of Trinity College, Cambridge, has been appointed reader in mathematical analysis in the University of Leeds, in succession to Dr. W. E. H. Berwick. Mr. Leonard R. Johnson has been appointed assistant lecturer in agricultural zoology.

DISCUSSION

THE CALORIMETRIC METHOD OF DETERMINING BLOOD FLOW IN THE EXTREMITIES

MY attention has been called to an article in SCIENCE (July 2, 1926) by Dr. Sheard in which he says; "I do not believe that the Stewart equation or any similar equation can be applied correctly to the determination of blood flow. Calorimetric data *per se* can be used only for the determination of heat elimination." I confess I am at a loss to make out what it is that Dr. Sheard thinks he has discovered, nor do the elementary formulae on heat conduction which he reproduces help at all. That the heat given off can be stated as the heat given off is, I believe, incontrovertible. That it may be useful for some medical or physiological purposes to so state it without endeavoring to procure the conditions necessary for translating it into terms of blood flow, may also be true. But that it is impossible to obtain the calorimetric data under standard conditions, permitting the blood flow to be calculated from them, is demonstrably an inaccurate statement. The necessary condition is that the temperature slope in the part from the deeper layers to the surface should be stabilized by a sufficiently long immersion in the bath before the readings from which the blood flow is deduced are taken. In other words, the preliminary immersion must establish a definite distribution of temperature in the part, or a definite average temperature of the part, which henceforth remains approximately unchanged throughout the period of an ordinary experiment. The heat then given off minute by minute to the calorimeter must represent the heat lost by the blood. Dr. Sheard must know, if he has read my papers, that it is not "calorimetric data *per se*," obtained anyhow, which are applied to determination of the flow, but data obtained under essential conditions. Yet no reader would gather from his article that the establishment of these conditions is part of the technique on which the validity of the equation depends.

I do not know whether the critic really understands what is implied in the position he apparently takes up, but what is implied is a denial of the possibility of producing the steady distribution of temperature mentioned.

Now this is sheer absurdity and demonstrated to be so, for instance, by measurements of deep and surface temperature, from the earliest observations to the most recent, such as those of Taylor and of Benedict. If a steady slope of temperature, in the sense in which the term is employed by us, can not be established in a part in a given environment, and supplied by a given stream of blood, the temperatures measured by these investigators would not remain constant long enough for observations to be made. The matter is not one which needs to be settled by discussion. Simple experiments, such as comparison of the temperature of different layers of an animal's leg (not too thick) with that of the water in which it is immersed, are recommended as instructive upon this point. Sheard's remarks on the disturbing effects of opening and closing of capillaries, according to Krogh's greatly overworked conclusions, and other factors are not entirely intelligible to me, and have, I think, little bearing on the point in question.

The fundamental condition, notwithstanding what Dr. Sheard may "believe," can be realized, and therefore blood flows can be deduced from the calorimetric data. The realization is naturally easier in thin than in thick parts, in parts whose chief blood flow is superficial than in parts where an important part of it is deeper. I have, as a matter of fact, always considered the hand as approaching most nearly to the ideal requirements because its dimensions and the distribution of the principal blood flow were the most favorable, and have never used the foot, in preference to the hand, except when necessary. This is not the place in which to recapitulate the rules which must be observed if the estimations are to be properly made. I have more than once been called upon for assistance by zealous but (in this matter) ignorant persons, who were violating the most obvious rules and were disappointed with the results.

Direct comparison of the results of the calorimetric method with that of other methods have given a satisfactory agreement. For instance, Utheim in Erlanger's laboratory compared the flow in the legs of dogs, measured by the stromuhr, with that deduced for the calorimetric observations. The agreement was good. Will Dr. Sheard inform us how this could be so if the calorimetric method did not give the blood flow?

I have myself laid great stress on securing data in human cases which serve as a test of the accuracy of the method. The most valuable of these data are in cases where a known mechanical interference with the circulation was produced. For instance, the innominate artery and right carotid were ligated for aneurism. The operation caused a great reduction in the right-hand flow. But there was a corresponding increase in the left-hand flow, so that the combined flows in the two hands remained unchanged (18.9 grams per 100 cc per minute before ligation and 18.8 grams after ligation). The cutting off of the path through the inominate obviously permitted more blood to enter the alternative route of left subclavian and left carotid. That the flow in the left carotid was increased after the operation was indicated by the increased throbbing and filling of the left temporal. The case was followed, as the collateral circulation opened up, for thirty-one days after the operation. The combined flow was twenty grams per 100 cc per minute seventeen days after the ligation. The ratio of right-hand flow to left-hand flow went on increasing steadily as the collateral circulation developed (1:4.5, 1:3.2, 1:1.8, 1:1.6 in successive observations). Only a very ignorant physiologist will believe that these numbers were deduced from data from which it was impossible to estimate the blood flow.

In another case (rheumatic endocarditis complicated by multiple emboli and thrombosis), studied along with Dr. R. W. Scott, the flow in the right foot became smaller (one fifth of that in left foot at the last examination), and before death the leg became much discolored. When the flow in the right foot diminished there was a corresponding increase in that in the left foot, and the ratio of combined foot flows to combine hand flows in the different examinations did not vary over four months. It was suggested (in a paper in the *Journal of Experimental Medicine*) from the reciprocal relation of the flow in the two feet that the obstruction was in the right common iliac and not, for instance, in the femoral. This was confirmed at autopsy about two months later. It would be inappropriate to claim that there might not have been an element of luck in the prediction. But it was made on the basis of blood flow measurements, and could only have been made on that basis. Numerous other instances could be given where any physiologist would at once recognize from the order of magnitude of the numbers and their relations to each other and to the anatomical or physiological conditions, that they must represent blood flows.

G. N. STEWART
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THE SHAPE OF CELLS IN MASSES

IN the issue of SCIENCE for June 18 is printed a communication from Frederic T. Lewis under the title "An Objective Demonstration of the Shape of Cells in Masses." This contains the following statement, page 608: "Meanwhile Lord Kelvin had found that a fourteen sided figure—a cube truncated by an octahedron—having six quadrilateral and eight hexagonal surfaces, solves the problem of dividing space without interstices into uniform bodies of minimal surface."

The statement is a correct expression of Lord Kelvin's claim as set forth in the somewhat famous Baltimore lectures of several years ago. But the claim is entirely wrong. Having been myself much perplexed by so direct and confident an announcement from such an eminent source, let me ask that a definite correction of a serious error be now made in order that others may be saved from being misled and perhaps from consequent mistakes.

The volume described, called the tetrakaidecahedron, does not possess the properties as stated. Equal volumes of this pattern will not fit together without voids, as a brief consideration of the diedral angles or angles between faces and the relations of these faces or a practical trial with models would at once have shown. Lord Kelvin's subsequent discussion of similar volumes with warped or distorted faces, which is referred to in Mr. Lewis's original papers, indicates that the error was later recognized

by its distinguished author, though the supplementary treatment was far from convincing.

This general subject was discussed at some length by the undersigned in a paper on "A Geometric Basis for Physical and Organic Phenomena" which was printed in SCIENCE for October 11, 1918. The same was afterwards privately reprinted under a general title, "Fundamentals of the Cosmos," with an addendum in which was outlined a still farther simplification of the basic principle referred to. This may be concisely formulated as follows: *In an aggregate of an indefinite number of points with equal intervals between neighboring points throughout, a grouping that will give both complete symmetry and maximum concentration or minimum total space occupied is impossible.* Herein is to be sought the key to the apparently anomalous or irregular forms which Mr. Lewis finds. His observations of the actual shapes of organic cells found in nature are exceedingly interesting and significant, but the conclusion he suggests that "cells in masses are typically tetrakaidecahedral" should, I think, be understood as meaning that this is a form to which natural organic cells often approximate; not one which they will ever be found actually to attain in groups or aggregates.

JOHN MILLIS

CLEVELAND, OHIO

THE BIG STONE GAP SHALE OF SOUTHWESTERN VIRGINIA

THE stratigraphic relationships of the Big Stone Gap shale and its bearing on the Chattanooga shale problem have long been an outstanding geological question. Ulrich, Bassler, Schuchert and others have regarded both as Mississippian in age. Kindle, David White, Butts and others have regarded them as Devonian. But neither group has been able to offer conclusive proof of its position. In Virginia the Big Stone Gap shale lies at the top of the Portage and, where recognized in the past, has always been overlain by lower Mississippian beds (Grainger and Price formations). Stose[1] made an effort to solve the problem by tracing the Big Stone Gap shale up from the southwest and the Chemung formation down from the northeast, but at no locality was he able to find them together.

The writer's studies in Tennessee[2] had led him to believe the Chattanoogan series entirely Mississippian, as held by Ulrich. Partially completed studies of the Big Stone Gap shale, especially in the vicinity of Mendota, have led him to alter that decision. Six miles northeast of Mendota a series of sandy shales and shaly sandstones were found above the Big Stone Gap shale, forming a ridge traceable for a considerable distance to the northeast, where it lies everywhere higher stratigraphically than the Big Stone Gap shale. In the shaly sandstones were found *Camarotoechia orbicularis, C. contracta* var. (identical with the small variety from the Maryland Chemung), and *Productella* cf. *hystricula,* all typical Chemung forms found in the middle Chemung of Maryland. The Big Stone Gap shale near Mendota is thus definitely Devonian in age.

The Big Stone Gap shale has been recognized for some ten miles northeast of Mendota, where it is found to be accompanied by an increasing number of sandstone and sandy shale beds. It would thus seem to be probably lower Chemung in age. Near Saltville a similar black shale was found in the base of the Chemung and is here tentatively correlated with the Big Stone Gap shale.

The completed study will be published shortly as a separate paper.

J. H. SWARTZ

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A STOCK FOR THE MANGOSTEEN

ON the hacienda of Mr. John R. Schultz, Calauan, Laguna, Philippine Islands, in May, 1924, I inarched a seedling of the mangosteen, *Garcinia mangostana* L., on a plant of a native species of *Garcinia,* locally called *Bunag.* A successful union was rapidly established, and the grafted plant had made a good start when last I saw it shortly before leaving Manila for the United States in January, 1925. Photographs recently received from Mr. A. W. Prautch, Bureau of Agriculture, Manila, show that the plant now reaches to a man's hips and is in excellent condition.

The success obtained in this graft is of more than ordinary interest in view of the fact that for a period of some 25 years attempts repeatedly have been made to graft the mangosteen on more than twenty species of *Garcinia* and related plants, all, except the instance recorded, ending in failure.

The mangosteen is one of the most highly prized fruits in the world, but is particular in its climatic requirements, has a weak root system, and is of very slow growth, especially in the nursery stage. Therefore, unlike many other fruits, the mango, for instance, the mangosteen has never become widely disseminated, and still is grown on a comparatively restricted area and in small quantities, notwithstanding its unsurpassed eating qualities and good shipping qualities.

The *Bunag* not only is a plant of vigorous growth which may be expected to force the grafted plants

[1] Va. Geol. Surv., Bull. 24, 1923, pp. 48 to 52.

[2] *Amer. Jour. Sci.,* Vol. 7, 1924, pp. 24 to 30.

into bearing several years in advance of mangosteens grown on its own roots, but it thrives exposed to a long dry season. Therefore, by the use of *Bunag* as a stock, it would appear feasible to extend the culture of the mangosteen over large areas where for climatic reasons this hitherto has been impossible.

P. J. WESTER

BALLSTON, VIRGINIA

QUOTATIONS

THE OXFORD MEETING

THE personality of the Prince of Wales as President, the amenities of Oxford, and the excellent arrangements made by the university and the city have all combined to make the meeting of the British Association, which ended recently, a conspicuous success. Even the copious reports of the daily proceedings sent by our correspondents gave an incomplete record of the multifarious activities of the sections. We have commented more than once on the disadvantages of division into thirteen concurrent sections, some of which even had further subdivision; but at least it has the merit of giving a wide display of the scope of modern science. The president in his address, almost by way of warning against any hasty judgment, reminded his hearers that theoretical research was often far in advance of practical application, and that even great men of science had sometimes under-estimated the implications of statements made to meetings. Lord Balfour, in his epilogue on the first evening, recalled that the last meetings at Oxford and at Cambridge had each been quickly followed by an efflorescence of physical discovery, and prophesied a similar consequence of the meeting this year. Sir Oliver Lodge, although admitting that he did not speak for the general body of science, suggested that the great advance would be an extension of the methods of science into the realm of the spiritual. But it may be that the next important discovery was really foreshadowed in the meeting of the Chemical Section on Tuesday. Hitherto the chemical element helium, although believed to be a constituent of all the elements above it in the scale, has refused all attempts of the laboratory to make it enter into combination with any other element. Mr. J. J. Manley explained a long series of experiments, conducted by himself, which pointed to a combination of helium with mercury and the formation of a "helide of mercury." This startling announcement, admitted to be as yet tentative, was said to have received the benediction of Professor Soddy, than whom there is no higher authority, and may well prove the starting-point of a new avenue to knowledge. Apart from this the work of the association at Oxford, both in theoretical and in applied science, was of a high order, and there were fewer than usual of the rather foolish or feeble communications which are sometimes accepted out of kindness.

On principle and from personal knowledge, the Prince of Wales in his address urged the advantage of close relations between science at home and science in the distant parts of the empire. It was an opportune comment, because the association has had to consider an invitation from the South African Association for the Advancement of Science, with the concurrence of General Hertzog, to hold the 1929 meeting in South Africa. The General Committee at each of its three meetings discussed the proposal, and on Tuesday evening instructed the Council to make the requisite inquiries as to date, period of absence from this country, cost to individual members, and general finance. No more could have been done for the present, but it is clear that the association has decided in principle to accept the invitation provided that the details can be adjusted. Naturally there are difficulties, but there are three years in which to meet them. July is the most convenient month for South Africa, since her universities begin their sessions in August, whilst our sessions linger well into July. But a compromise could be arranged, institutions and individuals here being released a little earlier, there beginning a little later. Those who can not spare the time for six weeks at sea might bear in mind that in all probability by 1929 it will be possible to go from London to Johannesburg in a week by aeroplane, certainly at no greater cost than that of a cabin passage by sea. South Africa is generous and hospitable, and—as on the former visit in 1905—the Government is likely to give free passes on the railways and the steamship companies to reduce their rates. It is true that, if the British Association holds its annual meeting in South Africa, there can not well be another during the same year in Great Britain without robbing both of some of their authority and their dignity. But, when all these temporary disadvantages have been weighed, there can be no doubt that a South African visit should prove a permanent advantage to science and to the empire.—The London *Times*.

SCIENTIFIC BOOKS

CONCERNING REPTILES AND FROGS

Reptiles and Amphibians: Their Habits and Adaptations. By THOMAS BARBOUR, Curator of Reptiles and Amphibians in the Museum of Comparative Zoology at Harvard College. Illustrated in part by George Nelson, Preparator in the Museum of Comparative Zoology. Boston. Houghton Mifflin Co.

BARBOUR'S "Reptiles and Amphibians" is a model of a popular treatise in natural history. It is throughout

accurate, clearly written, with as few technicalities as the subject permits. Moreover, admirably illustrated, and withal well printed. Every phase of reptile life is fully treated from the origin of the class estimated as some ninety million years ago (its forebears, the amphibia, three or four millions of years earlier), to the last note on the song of the tree frog. It concludes with a brief but wise commentary on Darwinism. Barbour remembers, what some evolutionists have forgotten, that the origin of species is an outdoor matter, in which nature takes her own time.

The numbers of kinds of these creatures, the world over, is far beyond the usual conception. Barbour estimates 6,875 living species; 50 of them crocodiles, 225 turtles, 2,300 snakes, 2,500 lizards, 1,500 frogs and toads, and 50 coecilians, blind, worm-like creatures. With the rest, one singular lizard of New Zealand, *Sphenodon,* of ancient type in which the ancestral middle eye (pineal) on top of the head is still extant.

Every phase of reptilian life is well considered. Some of the most interesting chapters relate to the poisonous snakes, the nature of their poison, and the methods of giving immunity through dilution of venom.

BERING'S VOYAGES

Bering's Voyages. An Account of the Efforts of the Russians to Determine the Relations of Asia and America. By FRANK A. GOLDER, in two volumes. Vol. II, Steller's Journal of the Sea Voyage from Kamchatka to America and Return on the Second Expedition, 1741–43.

A REMARKABLY valuable work, from the standpoint of geographical history as well as of natural science, is the record of Bering's voyages by Professor Frank A. Golder, of Stanford University. The first of these two volumes contains an annotated translation of the official reports. The second volume contains the Journal of Georg Wilhelm Steller, the gifted naturalist of the second expedition. This is especially interesting for the spirited narrative itself, and for the first account of "the four great beasts," Sea Lion, Sea Bear (Fur Seal), Sea Otter and Sea Cow, the last named now extinct. This journal is translated and in part annotated by Leonhard Stejneger, of the U. S. National Museum, whose own studies in this region have been of the highest importance.

American Geographical Society, Research Series, No. 2. W. L. G. Joerg, Editor. New York, 1925.

DAVID STARR JORDAN

SHERBORN'S "INDEX ANIMALIUM"

EVERY zoologist regards the accurate naming of animals as a matter of far-reaching importance. Sooner rather than later he must even refer to original papers or to complicated nomenclators, and find out whether his beasties have been described accurately, and whether names given to them have not been earlier used for entirely different creatures. It was the idea of simplifying this universal labor which led the English naturalist, Charles Davies Sherborn, to undertake the Herculean labor of preparing an index which should put an author's finger upon all species and genera hitherto described.

Beginning thirty years ago, Mr. Sherborn has overhauled all zoological literature from Linnaean beginnings to the year 1850, indexing (*mirabile dictu!*) some 27,600 works. His plan was to complete in an encyclopedic way the first century of zoology and to include, naturally, references to animals, recent and fossil, in the writings of all countries.

Thus far ten parts of his work have appeared, in all comprising 2,570 pages. Part I was published in 1902 by the Cambridge University Press: thereafter the work was taken up by the trustees of the British Museum. At the close of the present section (part X) the literature dealing with the genera and species has been accounted for from 1801 to 1850, up to the word *funereus.* The eleventh part, which will complete the letter G, will appear in December. The manuscript cards for the remaining letters are being revised, but from the nature of the task five or six years more will probably be required to complete the publication of an epoch which witnessed the description of the greatest number of animals. When this turning of the road has been reached, Mr. Sherborn plans to cease his labors and let the later literature be worked out by his successor, if such a one may be found. It would not be unfair to Mr. Sherborn to note that this vast work has been carried out largely as a labor of love.

BASHFORD DEAN
THE METROPOLITAN MUSEUM OF ART

SPECIAL ARTICLES

LOSSES IN TROUT FRY AFTER DISTRIBUTION

ON seining a quarter of a mile of Forbes Brook, Prince Edward Island, Canada, there were found, October, 1925, trout, yearlings and older, 319; fundulus, 82; salmon parr, 33; stickleback, 16, 152; a

total of 16,586. At the same time only about 1,066 trout fry were found alive out of 4,020 distributed in this same area in July, 1925.

Does not a loss like this (73 per cent.) take place in accordance with the generally accepted biological principle that animals in a state of nature tend to breed up to the limit of subsistence? Even men breed in conformity with this law in thickly populated parts of India and China and in the slum parts of all big cities. Forbes Brook, like most others, produces food enough to feed only a limited number of fish, just as 50 acres of pasture land can feed only a limited number of cattle.

Now a majority of the 319 trout, 82 fundulus, and 16, 152 stickleback during the spring and summer of 1925 bred up to the limit of subsistence, and therefore there would be no extra food for the 4,020 weak and helpless fry which were dumped among the 16,586 enemies and competitors. The result was that some of the 4,020 were devoured by the larger and more active enemies, while others of them, weakened by scarcity of natural food, either died, or, it may possibly be, succumbed to the combined attacks of their numerous competitors, such as the stickleback.

May I suggest, therefore, that we have been trying to build up our fish culture results upon too narrow a foundation, namely, hatchery work alone for over 50 years. We have been limiting our protection of the fry and our feeding of fry to the comparatively short time which they pass in the hatchery. The hatchery, it must be remembered, is only one factor in the artificial production of commercial or game fish. Besides the hatchery there are the streams, ponds, etc., in which the fry are distributed and which must be studied quite as diligently as hatchery operations if fish culture is to be made successful. We must find out (1) the kind and numbers of enemy and competitor fish; (2) the available food supply, and (3) the limiting factors, forces or conditions which nature imposes upon the continuance of life, such as temperature of the water, oxygen supply, carbon dioxide, salinity, hydrogen ion concentration, intensity of light, pressure, desiccation and pollution.

Of the three factors just mentioned—enemies, food supply and physical condition—undoubtedly the most difficult and most important one to determine is the food supply in the streams and lakes in which the fry are distributed.

Remedial Measures

1. The ordinary hatchery employee who possesses no scientific knowledge may nevertheless become an expert seiner and procure information as to the different kinds and numbers of enemy and competitor fish. How many of such fish should be removed and destroyed can only be determined by experiment. In order to promote efficiency in seining, surplus cover in the shape of shrubs, large stones, and submerged logs should be removed by the hatchery employees during off time in spring, summer and autumn.

2. Many enemy fish and competitor fish should be seined and destroyed for the same reason that weeds are destroyed in a garden, or wolves on a sheep farm. In this way more food would become available if not immediately for the fry, at least for yearlings or older ones. The food supply and limiting factors on the other hand can be determnied only by well-trained biologists. Until fish culturists extend their knowledge along the following lines so as to form a proper foundation for their science it will be idle to expect the best results.

3. A quantitative estimate to be made of the microscopic and macroscopic animal food upon which both fry and adults live.

4. A quantitative estimate to be made of the plant food upon which the microscopic and smaller macroscopic animals live.

5. An approximate quantitative determination to be made of the substances in solution in the water and which constitute the nutritive material upon which minute aquatic plants grow. These plants in turn form the food of minute aquatic animals.

So then we have this chain of nutritive relations to be studied: adult fish: minnows and fry: minute animals (entomostraca, etc.): minute plants: soluble material or food for the plants.

It may be objected that this broad study of the foundations of the science of fish culture will be an expensive affair. Yes, at first, and until the animals, plants, mineral matter and limiting factors have been determined. But once they are determined we shall have the satisfaction of knowing more or less accurately the approximate numbers of adult fish which we are getting for our legislative appropriations, instead of the guesses which pass current to-day.

A. P. KNIGHT,

Chairman, Biological Board of Canada

KINGSTON, ONTARIO

SEX DIFFERENCES IN MORTALITY AND METABOLIC ACTIVITY IN DAPHNIA MAGNA

FROM studies of the relative mortality of the sexes in *Daphnia magna* throughout their life span a mor-

tality curve has been constructed for this species based on deaths of several thousand individuals all derived parthenogenetically in a pure line from a single original female. The organisms were reared, some singly, mostly in groups of varying size in battery jars containing at least 40 cc of ordinary manure-soil culture solution per individual. A census of survivors in the populations was taken at each seven-day period.

The mortality curves from this data show that under the laboratory conditions defined the males survived far better than the females during early and middle life, but that in later life (past the point of downward inflection of the curve) the males die off much more rapidly per unit of time than the females.

Experiments instituted to explain these differences revealed several points of interest in connection with physiological sex differentiation in its relation to duration of life:

(1) The males possess a characteristic higher rate of metabolism than the females throughout life until the decline during senescence sets in, when the female rate approaches and finally comes even to exceed that of the males. The observed greater locomotor activity of young males in comparison with young females led to an investigation of their relative heart-beat rates as a measurable criterion of metabolic activity. From Robertson's work the frequency of beating of the daphnid heart is known to be a function of temperature, the temperature coefficient being slightly greater than 2. As counted against a stop-watch at laboratory temperatures the frequency of heart beat of our young males was found to exceed that of young females by approximately 20 per cent. On the contrary, the rate for very old (always more sluggish) males proved to be some 5 per cent. lower than that for females of the same age.[1] As further evidence of the relatively more intense metabolism of males among the young and of females among the old, they were found to pass more quickly into a state of anesthesia with 3 per cent. alcohol, and then to recover sooner from its effects, and again, when tested with rapidly acting killing agents they showed correspondingly higher direct susceptibility and succumbed more quickly. In general, the curves for heart rate, direct susceptibility, anesthesia and for survival under ordinary culture conditions are quite precisely parallel at all ages.

(2) The mortality curve for Daphnia represents a curve of deaths by indirect susceptibility, according to the method of Child. The metabolically more active sex at any given age tends to have a higher average survival frequency, as though vigorous physiological functioning were regularly associated with comparative resistance to ordinary untoward conditions of the environment. Conversely, that sex succumbs more rapidly under the usual laboratory living conditions, which shows least resistance to ordinary slow-acting killing agents or to excessive crowding conditions (twenty-five to fifty specimens in as many cc of medium), these being lethal only after acting for several days.

(3) The relative longevity of the sexes may be expressed as varying inversely with their average rates of metabolic activity. The average age at death for males was 37.8 days and for females 43.53 days, the duration of life for females exceeding that for males by 14.6 per cent. Now in metabolism, as estimated by heart rate, the males surpass the females by nearly the same percentage, and the product: heart beats per second (weighted average through life) × average age in days at death = a constant, *e.g.*

Males: 4.3 beats × 37.8 days = 161.54
Females: 3.7 beats × 43.8 days = 162.06

The experimental data thus tend to support the view that a definite endowment of vital energy, potential in the protoplasm of the species and line, may be transformed and expended rapidly, as in the short-lived males, or more slowly, as in the longer-lived females. The evidence so far available indicates also that length of life in *Daphnia magna* has the usual temperature coefficient for a chemical reaction. Other factors being equal, it would seem that, at least in this species, longevity is a function of metabolic rate.

If a workable method can be devised the metabolic rate will be measured from quantitative determinations of oxygen consumption and CO_2 production.

A more extended report, including details of data on the various phases of this work, will be published elsewhere.

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[1] Rapidity of heart beat also varies with special conditions of culture. "Crowding" females for male production promptly slows down the heart beat to only four fifths that of "single" females, which produce mostly female young. This observation agrees well with the current view that a state of depressed metabolism during maturation of the ova is associated with the onset of the sexual phase.